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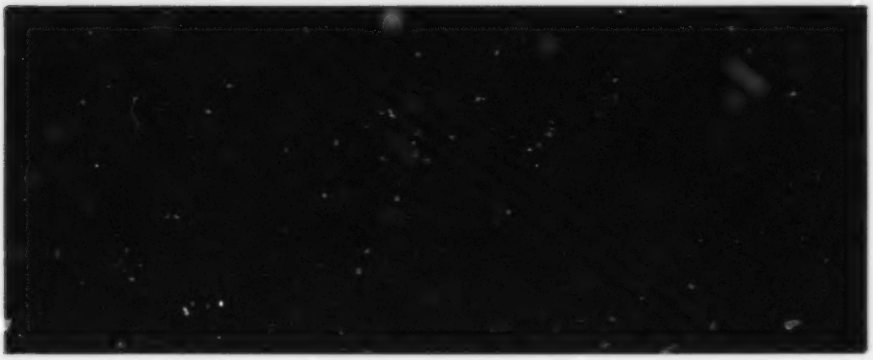

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91-02627/

Final Report

2.1-14

Pathophysiology of Testicle Size in Yearling Bulls

Conducted by
W.F. Cates, A. Palasz and R.J. Mapletoft

Funded by the Agriculture Development Fund

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PATHOPHYSIOLOGY OF TESTICLE SIZE IN YEARLING BEEF BULLS

W. F. Cates, A. Palasz and R. J. Mapletoft
Western College of Veterinary Medicine
University of Saskatchewan
Saskatoon, Saskatchewan S7N 0W0

ABSTRACT: A 3-year study was designed to establish relationships between testicle size and traits which ultimately determine fertility in beef bulls. A total of 145 bulls mainly representing two breeds, Hereford (73), Simmental (63) and Angus (4) and Charolais (5) with a range in scrotal circumference (SC) measurements between 28.5 and 41.5 cm were used. Just prior to slaughter at 14 to 15 mo. of age SC measurements were taken, semen was collected and GnRH was injected to determine endocrine responses. Testicles were processed for daily sperm production (DSP), epididymal sperm reserves (ESR), seminiferous epithelial area (SEA) and degree of germinal epithelial losses (DGEL). There were significant ($P<0.05$) positive correlations between SC and testicular weight ($R=0.9$), ESR ($R=0.7$), DSP/gr ($R=0.4$), DSP/bull ($R=0.7$), however, the correlation between SC and SEA was not significant. SEA was positively ($P<0.01$) correlated with DSP/gr ($R=0.6$) and DSP/bull ($R=0.6$). SC was negatively ($P<0.05$) correlated with DGEL ($R=-0.5$) and DGEL was negatively ($P<0.01$) correlated with DSP/gr ($R=-0.7$), DSP/bull ($R=-0.7$) and ESR ($R=-0.6$). Morphological characteristics of spermatozoa were diversely related to the above. Although GnRH stimulation did not reveal any evidence of gonadotropin deficiency in any of the bulls, with SC measurements less than 31 cm had peak testosterone levels that were significantly lower that those bulls with SC above 31 cm.

BACKGROUND: Evaluating and managing the herdsire for reproduction is one of the most important factors for the beef breeder, since his entire income derives from calves born, making fertility indisputably the most important trait. Economically, reproductive merit is 5x more important than growth performance and 10x more important than product (carcass) quality to the cow-calf producer. Considering the 1:10 000 ratio or more of the AI sire or 1:25 to 1:100 ratio of the herd bull used for natural service, fertility of the bull is much more important than that in any single female. This is the main justification to pay greater attention to the fertility of beef bulls. However, little to no

selection has been placed on the fertility of the North American beef bull population. In addition, multiple sire breeding, used routinely by many breeders, has made it difficult to identify sub-fertile bulls. Populations of beef bulls which are deficient reproductively are estimated to range from 20 to 40% and many more are barely adequate. These are the main reasons why selecting beef bulls must be given greater priority.

One of the most critical aspects of determining a bull's reproductive potential is testicular development and related seminal parameters. Therefore, testicle size measured by scrotal circumference (SC) is one of the most important factors in the evaluation of breeding soundness of beef bulls. Scrotal circumference measurements are easily obtainable and repeatable which allows with high degree of probability , the prediction of the breeding potential of a bull. Considerable effort has been made to correlate SC with breeding potential of the male. However, convincing data relating SC measurements to traits such as morphology of sperm, histology of testicular parenchyma, hormone profiles, or sperm production are still being questioned. Larger testicles are desirable, since bulls with larger testes produce more spermatozoa. However, the SC is seldom a limiting factor if the testes are normal and of adequate size, because bulls used in natural service have a much larger reserve of sperm production than the demands placed upon them. Recently, infertility and reduced fertility has been shown to occur in sexually mature bulls with small testes (hypoplasia) or in bulls with severe lesions of testicular parenchyma. Bulls with SC measurements of 27 to 29 cm at 2 to 3 year of age usually have total testicular hypoplasia with only Sertoli cells present in seminiferous tubules. The most commonly encountered condition is partial hypoplasia in which both hypoplastic and normal tubules are present. Bulls with partial hypoplasia often have a SC close to nonhypoplastic bulls and may produce sufficient numbers of spermatozoa for satisfactory fertility rates when they are not heavily used. However, they eventually become completely sterile, because their functioning seminiferous tubules undergo atresia relatively early in life.

The real question is, how large is large enough ? Minimum accepted SC measurements have been established for various breeds at various ages (table 1). However, these recommendations were based on one standard deviation below breed averages and were only indirectly based on testicular function. Therefore, it is necessary to standardize breed and age in order to clarify the relationship between SC and eventual fertility. In addition, detailed testicular examinations for a measure of function were necessary to establish whether these recommendations were sound. An experiment was designed to investigate SC measurements and testicular function in various breeds of beef bulls at a constant age.

OBJECTIVES:

1) To examine the relationship between SC measurements and testicular function in young beef bulls of different breeds by determining:

   a) daily sperm production (DSP)
   b) epididymal sperm reserves (ESR)
   c) degree of germinal epithelial losses (DGEL)
   d) seminiferous epithelial area (SEA)
   e) testosterone (T) and luteinizing hormone (LH) release in response to gonadotropin releasing hormone (GnRH).
   f) morphology of semen

2) To establish minimum SC measurements for 14-15 month old beef bulls of different breeds, above which the probability of

   normal fertility would be high.

A METHODS - 1987

In 1987, twelve 15-month old beef bulls representing three breeds, (Charolais, Hereford and Angus) were used to represent a range in SC measurements between 28.5 and 34.0 cm. Bulls were selected at the end of ROP test and with the owners permission. Measurements of SC were taken on all bulls, and semen was collected using the electroejaculater. The volume and density of the ejaculate and motility was recorded. A total of 200 spermatozoa from each sample were evaluated for morphology (percent normal sperm). After semen collection, blood plasma was obtained every 30 min. for 3 hours for measure of LH and T production. After the first 30 min. 200ug of GnRH was administered (IM) to determine the responsiveness of the bulls pituitary gland and in turn the endocrinologic function of his testicles. Plasma was separated by centrifugation and stored at -20^{0}C until assay for LH and T. All bulls were slaughtered within 10 days after blood collection (15/mo +/- 1/wk of age) and testicles were collected, trimmed of the tunica vaginalis, blotted dry and weighed. The epididymis was then removed, weighed and frozen at -20^{0}C until further processing for ESR. Cross sectional samples were taken from three different sections of each testicle (head, cauda and middle portion) for histological examination. Additional tissue samples from each testicle were frozen at -20^{0}C for further evaluation of DSP. Histological changes in the seminiferous epithelium and interstitium were examined by light microscopy and were graded 0 to 7:

grade 0 - normal seminiferous epithelium;
grade 1 - seminiferous epithelium with pyknosis and focal vacuolation
grade 2 - seminiferous epithelium with intermediate changes between grades 1 and 3

grade 3 - seminiferous epithelium with mostly spermatogonia and Sertoli's cells
grade 4 - epithelium with mostly vacuolated Sertoli's cells
grade 4a- hypoplastic tubules with only Sertoli's cells and without any vacuolation
grade 5 - no epithelium, only basement membrane
grade 6 - tubules with sperm granuloma and mineralization
grade 7 - tubules with only fibrous elements

A total 600 randomly selected tubules (100 from each section) were evaluated from each bull. Degree of germinal epithelial losses (DGEL) were calculated from 100 randomly selected tubules from each bull. The percentage of tubules in each grade was multiplied by the respective assigned weight: 0 and 1 was assigned to each grade - 0, 1/4, 2/4 and 3/4 to grades 0, 1, 2 and 3, respectively and 4/4 to grades 4 through 7 and the product was summed to indicate relative DGEL. Seminiferous epithelial area (SEA) was determined using computer image-analyzer from 100 randomly selected tubular cross sections with a round and visible lumen as the area enclosed between basement membrane and lumen. The SEA was expressed as the actual area per 100 tubule cross sections for each animal and taken as the mean values from left and right testes. Daily sperm production (DSP) per bull and per gram of testes were determined from testicular homogenats using a time divisor of 5.32 which is the number of days production of spermatozoa represented by the spermatids counted in the testicular tissue homogenates. Epididymal sperm reserves (ESR) were calculated for caput, corpus and cauda epididymis using procedure similar to calculating of DSP.

RESULTS and DISCUSSION.

Because of the number of bulls available in 1987, it was not possible to make breed comparisons. However, data confirm an earlier assumption that larger testicles have a greater capability of total normal sperm production, as expressed by DSP/bull (table 2). Although quantitative analysis of seminiferous tubules as expressed by SEA did not reveal any relationship with SC, morphological evaluation of seminiferous tubules (table 3) suggests that degree of vacuolation appeared to be increasing as SC decreased. Morphological evaluation of semen (table 4) showed a diverse pattern of relationships. Percent of total abnormal cells were not correlated with SC, however, increased percentages of spermatozoa with morphological abnormalities was related to relatively higher numbers of

seminiferous tubules graded as 0 to 3 (pyknosis and various degree of focal vacuolations) which are considered to be reversible. Lack of a relationship between these abnormalities and morphology of seminiferous epithelium may also suggest late maturing bulls or disfunctioning epididymides.

B. METHODS - 1988

In 1988, 13 Hereford bulls representing SC measurements between 29.5 and 36.0 cm were available. Bulls were evaluated according to the protocol used in 1987. Although data from 1987 and 1988 were combined making a total of 25 bulls, comparisons between breeds were still difficult. However, by grouping bulls into 5 groups, based on SC measurements, we were able to make statistical comparison between SC and other quantitative parameters (tables 5-6).

RESULTS and DISCUSSION

Bulls with SC larger than 31 cm had no significant differences in DSP/gr or DSP/bull. This can be explained by the narrow range in testicular sizes in bulls with SC larger than 31 cm. Bulls with SC below 31 cm had visibly reduced numbers of spermatozoa per gram of tissue and per bull, again reflecting tendency that with decreasing testicular size, the degree of morphological degeneration of seminiferous tubules (DGEL) also increased. In this study, mild vacuolations of seminiferous tubules graded as 0, 1 and 2 were observed in all bulls. Mild vacuolation (4%) of seminiferous epithelium has been shown occur in 90 % of the beef bulls as a consequence of natural cell degeneration. This means that although a few seminiferous tubules were involved in degenerative processes as in almost all young bulls, these mild changes should not affect semen quality. In this study, advanced degeneration, grades of 4 and higher, were found mostly in bulls with SC measurements < 31 cm. (table 3) reflecting a loss of germinal cells. As degeneration progressed, all germ cells disappeared and only vacuolated Sertoli cells remained. Finally, Sertoli cells also disappeared and only the basement membrane remained. The prevalence of hypoplastic tubules, grade 4a and higher, would not be expected to increase with age, because hypoplastic tubules do not arise after puberty. The majority of hypoplastic tubules found in this study were in bulls with SC measurements < 30 cm. Seminiferous epithelial area in bulls with SC measurements of less than 30 cm, irrespective of whether the testes were degenerated or hypoplastic, was less than that in bulls with SC > 30 cm. The patterns of LH release in response to GnRH stimulation in the bulls with SC < 31 cm were similar to those of bulls with SC > 31 cm except for slightly higher amplitude of peaks. Plasma concentrations of testosterone increased after LH peaks in all bulls and differences were not significant. However, bulls with SC measurements < 31 cm had peak levels of T that were less ($P<0.05$) than those with SC > 31 cm.

(table 7).

C. METHODS - 1989

In 1989, in collaboration with Dr. W. Johnson from the University of Guelph, 58 Hereford and 63 Simmental bulls were evaluated. These bulls were participating in growth trials in which the major objective was to test rations which would maximize growth rate and ensure good animal health and reproductive performance. The bulls were obtained from 30 producers across central and southwest Ontario and had satisfied preconditioning requirements and physical inspection for inclusion in the Ontario ROP Bull Test Program. Ultrasonic measurements of back-fat and testicles, live weight gain and SC measurements were collected every 28 days to determine diet and breed effects on reproductive soundness. Semen was collected from each bull for morphology and motility approximately 1 wk prior to slaughter. A serial slaughter was conducted over a 5 wks period to enable collection and examination of collected samples. Average age of Hereford bulls at slaughter was 14.25 + 0.14 mo. and Simmental bulls was 13.75 + 0.12 mo. Testicles were collected and processed according to protocol from the two previous years.

RESULTS and DISCUSSION

Mean SC for Simmental bulls was at slaughter 35.5 + 0.8 cm with only three bulls with SC smaller than 33.0 cm. Mean SC measurement of Hereford bulls were 32.5 + 0.8 with five bulls with SC less than 31.0 cm (table 8). Although results did not reveal any effect of diet on reproductive parameters, there was a relationship between back-fat measurements (mm) and breed (2.48 + 0.66 in Simmental vs 5.90 + 0.31 Hereford; $P<0.001$) and paired testis weight (high back fat - low paired testis weight; $R = -0.4$). Simmental bulls were heavier ($p<0.01$) than Hereford bulls at slaughter, had 20 % greater testes weight, higher DSP/bull and total ESR ($p<0.01$). There were no differences in percent of normal sperm (70.46 vs 68.07) and total DGEL (24.17 vs 21.46) between Simmental and Hereford bulls, respectively. Higher than expected DGEL may have been related to diet and requires further investigation. The number of cells which had to be evaluated (72.600; 600 per bull x 128 bulls) makes final assessment at this time difficult. However, the vast majority (99%) of pathological changes in seminiferous tubules of Simmental bulls with SC>33 cm and Hereford bulls with SC>31 cm were vacuolation graded from 1 to 3, representing reversible changes. Again all these changes occur in healthy animals, since seminiferous epithelium is very sensitive to a variety of physical, chemical, nutritional, endocrine and pathological disturbances. Very severe losses of

germinal epithelium were found in five bulls (despite of breed) with SC less than 30 cm. Two bulls out of five had hypoplastic tubules, without a central lumen and no vacuolation indicating that these tubules had not developed and that germinal cells were never present. The loss of germinal epithelium and the decrease in SEA ultimately resulted in decreased testicular size. This conclusion is supported by the negative correlations between SC and DGEL for bulls with SC <31 cm; Tables (9-10). These results provide convincing evidences that SC measurements less than 31 cm have a high probability of being associated with testicular hypoplasia. However, additional observations must be made before additional levels of probability can be assigned to progressively increasing SC measurements. Morphology and progressive motility of sperm in the ejaculates from these bulls correlated positively with SC ($p<0.05$) and negatively ($p<0.05$) with DGEL in both breeds. However, some bulls with severe tubular atrophy were able to produce morphological normal sperm, which suggests that remaining intact tubules were able to produce normal spermatozoa for period of time prior to complete cessation of spermatogenesis. Daily sperm production was positively correlated with SC and testicular weight ($p<0.0001$) and negatively correlated with back-fat measurements ($p<0.04$).

CONCLUSIONS:

Results indicate that measurements of SC indirectly assesses testicular health and can be a valuable predictor of reproductive potential in young bulls. Poor semen quality was associated with small testicles in this study. Two Hereford bulls out of five with SC of less than 31 cm were azoospermic. The other three had irreversible changes in the seminiferous epithelium and an increased incidence of abnormal spermatozoa and poor motility. Three Simmental bulls with SC<33 cm had an increased number of abnormal seminiferous tubules (33.3%) with most showing irreversible changes with poor semen quality. In Simmental bulls with SC>33 cm, 24.6% of tubules were affected but most had reversible changes. Although the numbers of bulls in each breed with small testicles was not large, histological data suggest that Hereford bulls with SC < 31 cm and Simmental bulls with SC < 33 cm are likely to be sub or infertile. This is exactly the recommended minimum SC measurement for these two breeds at 13 mo of age (table 1). Responsiveness of the pituitary to GnRH injection may be of some use to assess a bull's fertility status since bulls with small testicles and degenerated testicular tissue had a significantly lower testosterone peak two hours after injection. This is probably more a reflection of testicular function than cause-effect relationship for testicular hypoplasia.

IMPACT.

Economically, reproduction is the most important

consideration for the cow-calf producer. An increase in the Saskatchewan calf crop of 1% with a decrease in the average breeding season by one to two weeks would net Saskatchewan Cattlemen $10 - 20 million annually. Similarly the Saskatchewan Lands Branch estimates that adding one year productive life to their bull battery would realize a saving of $240,000 annually. Therefore, improved measures of reproductive function in the young beef bull would be off economic benefit. These are the first solid data relating histological measures of testicle function to SC measurements. Although data are yet incomplete, they suggest that at 12 - 14 mo. of age Hereford bulls with SC measurements less than 31 cm and Simmental bulls with SC measurements of less than 33 cm are likely to be reproductively deficient. Therefore, bulls with SC measurements in this size range must be considered reproductive risks. Coincidentally, this size recommendation is exactly that which we have previously made for these two breeds, based on averages. These data give support for our previous recommendations and even though data are incomplete for breeds other than Simmental and Hereford, there are compelling reasons to support the recommendations for minimum SC measurements in these breeds. Adherence to these recommendations can improve the level of fertility in our beef herds and should yield returns at levels alluded to earlier.

PUBLICATIONS, PRESENTATIONS and OTHER BENEFITS.

During the tenure of this contract considerable research data, in the area of physiology of reproduction of beef bulls have been generated. However, more data should be generated for breeds other than Hereford and Simmental. Preliminary data from this project were presented at Annual Meeting of Society for Theriogenology, Cour d' Alene, Idaho, September 29-30,1989, and this paper was awarded a prize for merit. Results will be presented in a full length paper in collaboration with Dr. Johnson at the 1990 meeting of the Society for Theriogenology in Toronto. We are also preparing a manuscript for publication in a referred scientific journal. We must continue to add data to complete the data set for all breeds in time. We have regularly kept patrons of the Saskatoon ROP Bull Test Station informed of the progress in this project and a copy of the Executive summary will be forwarded to them.

SEMINARS

R.J. Mapletoft - 1989 - Fertility and management of the beef bull. Peace River Cattle Days. Fairview, Alberta and High Prairie, Alberta.

R.J. Mapletoft - 1989 - Selection and management of the yearling bull - Pathow ROP Field Day.

R.J. Mapletoft, W.F. Cates and A.D. Barth - 1989. Fertility testing in beef bulls - A one day course. SVMA Annual Convention.

W.F. Cates and A. Palasz - 1988 - Fertility of yearling beef bulls - Relationship between histology of testes and testicular size in yearling beef bulls. WCVM, Saskatoon, Seminar of Physiology of Reproduction Group.

PERSONNEL

Andrzej Palasz - Research Associate - 50%
Jennifer Saunders - summer student
Noeline Willmott - summer student
Kun Xu - graduate student
Heng Wang - graduate student
Mingcheng Wu - graduate student
Antonio Garcia - graduate student
Gabriel Bo - graduate student
William F. Cates - Professor - 10%
Walter H. Johnson - 5%
Reuben J. Mapletoft - 5%
Albert D. Barth - Professor 1%

PATHOPHYSIOLOGY OF TESTICULAR SIZE IN YEARLING BEEF BULLS

W. F. Cates, A. Palasz and R. J. Mapletoft
Western College of Veterinary Medicine
University of Saskatchewan
Saskatoon, Saskatchewan S7N 0W0

EXECUTIVE SUMMARY

ABSTRACT: Over a 3 - year period, 145 ROP bulls were slaughtered between 13 and 15 mo. of age in order to determine the relationship between scrotal circumference (SC) measurements and other measures (including histology) of testicular function. SC measurement and paired testicle weights were highly correlated suggesting that SC is a good measure of testicle size. SC measurement was also correlated to measures of sperm production such as daily sperm production and epididymal sperm reserves. Finally, SC was correlated negatively with the degree of testicular degeneration, suggesting that as SC decreased, the amount of testicle degeneration increased. Data also suggest that 13 mo. old bulls with SC measurement below 31 cm (Hereford) and 33 cm (Simmental) are likely to have fertility problems. Insufficient data were available to draw similar conclusions for other beef breeds.

SUMMARY:

A study involving ROP bulls at the end of the test was designed to examine the relationship between scrotal circumference measurements (SC) and other measures of testicle function as determined by examination of testicles at slaughter. The purpose of the study was to develop reliable recommendations for SC measurements of bulls in the various breeds at 12 - 14 mo. of age. In 1987, 12 bulls representing the Charolais, Hereford and Angus breeds were examined. They had SC measurements ranging from 28.5 to 34 cm. In 1988, 13 Hereford bulls with SC measurements ranging from 29.5 to 36 cm were examined. Just prior to slaughter at 15 mo.of age, SC measurements were taken and bulls were electroejaculated for semen evaluation. In addition, bulls were injected with the pituitary stimulating hormone, gonadotropin releasing hormone and blood was taken to measure luteinizing hormone release and testosterone release. After slaughter, testicles were removed, weighed and examined histologically for function. In addition, tissues were processed for two quantitative measures of sperm production, daily sperm production and epididymal sperm reserves. Within this group of 25 bulls, sperm production parameters seemed to divide at a SC measurements of 31 cm. Below this measurement there were reduced numbers of spermatozoa produced in the testicle and a greater

degree of degeneration in the sperm producing tubules. Degenerative changes in bulls with SC below 31 cm were considered irreversible where-as those observed in bulls with SC above 31 cm were considered reversible. Bulls with SC measurements of 30 cm or less had a very high proportion of hypoplastic sperm producing tubules with no chance of recovery. In addition, quantitative measures revealed a greater level of sperm production in bulls with a SC measurements greater than 31 cm. However, the narrow range of SC measurements above 31 cm (up to 36 cm) and the small number of bulls failed to reveal a linear relationship between SC measurement and quantitative measures such as daily sperm production and epididymal sperm reserves. Peak testosterone levels were also lower in bulls with SC measurements below 31 cm. This suggest that a SC measurements of 31 cm or less is indicative of not only impaired and reduced sperm cell production but also reduced endocrine function in the production of testosterone.

In 1989, in collaboration with Dr. W. Johnson from the University of Guelph, 58 Hereford and 63 Simmental bulls were evaluated at an age ranging from 13.5 mo. and 14.5 mo. At slaughter the average SC measurement for Simmental bulls was 3 cm larger than for Hereford bulls. Simmental bulls also had 20% greater testes weight, greater sperm production and higher epididymal sperm reserves. As in the previous 2 years, Hereford bulls with SC measurements below 31 cm has less sperm production, as measured by daily sperm production and epididymal sperm reserves and a greater degree of sperm producing epithelial degenerative change, especially that of a irreversible nature. On the other hand, similar changes were seen at a SC measurements of 33 cm for Simmental bulls. These findings are supportive of our earlier recommendations that the minimum acceptable SC measurements at an age of 12 - 14 mo. should be 31 cm for Hereford bulls and 33 cm for Simmental bulls. Numbers of bulls with small testicles were insufficient to conclude much more. There were insufficient numbers of bulls with small testicles other breeds to draw similar conclusions. Data are also required on breeds that are known to have exceptionally small SC measurements (eg. Limousine and Saler) so that recommendations for minimum SC measurements can be made for these breeds.

Table 1. Recomended minimum scrotal circumference for bull sale. Bulls by age and breed.

AGE	Simmental*	Angus & Charolais	Hereford & Shorthorn	Other breeds
12-14	33	32	31	30
15-20	35	54	33	32
21-30	36	35	34	33
>30 mon	37	36	35	34

G.Coulter, W.F.Cates - 1981

Table 2 Relationship between SC and functional traits of testis (n=12; 1987)

Bull nr.	SC cm	weight test/gr	weight epid/gr	ESR $x10^9$	DSP/bull $x10^9$	SEA/ $100mm^2$
138	34.0	613	43.6	19.3	8.7	22
16	33.5	641	39.1	18.9	8.0	23
25	32.5	461	43.4	14.6	4.3	21
166	31.5	523	47.1	16.9	9.1	31
168	31.0	423	44.9	21.8	6.2	22
207	31.0	534	35.6	16.1	6.9	24
12	30.0	416	36.8	13.2	4.7	19
133	30.0	461	48.3	13.3	3.5	25
134	30.0	458	37.7	10.7	3.9	19
17	29.5	444	42.6	15.1	47	13
208	29.5	440	41.1	12.3	2.9	12
114	28.5	330	37.1	0.0	0.0	06

Table 3. Histological evaluation of seminiferous tubules (n=12; 1987)

	Percentage of seminiferous tubules graded as:									
SC cm	0	1	2	3	4	4a	5	6	7	DGEL (%)
34.0	82.3	6.0	6.8	1.3	1.0	0.5	-	-	-	7.3
33.5	83.0	8.0	5.2	1.8	1.2	0.3	0.5	-	-	7.7
32.5	68.8	15.8	11.6	2.5	0.5	0.5	0.7	-	-	13.1
31.5	76.6	9.0	9.8	2.8	1.2	-	0.3	-	0.2	10.6
31.0	78.7	12.7	6.2	1.3	0.8	-	0.5	-	-	8.4
31.0	77.2	7.2	9.7	4.0	1.5	0.3	0.2	-	-	11.5
30.0	49.3	31.3	12.2	0.8	-	0.3	-	-	-	15.5
30.0	57.0	32.6	9.3	-	-	0.8	0.2	-	-	13.8
30.0	57.5	25.3	11.5	3.8	1.8	-	-	-	-	16.7
29.5	65.8	14.7	15.3	2.8	-	1.2	-	0.3	-	15.0
29.5	48.6	27.0	15.6	5.3	1.5	-	1.0	-	0.8	21.9
28.5	-	-	-	37.0	51.8	9.5	1.6	-	-	90.7

Table 4. Morphological evaluation of semen (1987)

bull nr.	scrotal circ./cm (SC)	head def. %	mid def. %	tail def. %	proxim. droplets %	distal droplets %	normal %
138	34.0	9.0	12.0	1.0	2.0	31.0	45.0
16	33.5	9.0	9.0	0.0	12.0	11.0	65.0
25	32.5	5.0	12.0	1.0	1.5	28.0	58.0
166	31.5	8.0	10.0	1.0	2.0	4.0	72.0
168	31.0	4.0	1.0	0.0	2.0	23.0	70.0
207	31.0	14.0	6.0	0.0	1.0	5.0	60.0
12	30.0	4.0	15.0	0.0	2.0	9.0	39.0
133	30.0	3.0	20.0	0.0	1.0	0.0	70.0
134	30.0	6.0	4.0	0.0	1.0	0.0	87.0
17	29.5	3.0	20.0	1.0	1.0	7.0	77.0
208	29.5	13.0	1.0	0.0	1.0	0.0	83.0
114	28.5	-	-	-	-	-	0.0

Table 5. Relationship between SC, seminiferous epithelium histology and sperm production paremeters (Mean±SE) **(1987-88)**

Bulls (n)	SC (cm)	Test. weight (gr)	DSP/gr $x10^6$	DSP/bull $x10^9$	Total ESR $x10^9$	SEA/100 mm^2	DGEL %
3	35.0 ± 0.4	658 ± 23.6	10.9 ± 1.4^{ac}	7.1 ± 0.8^{a}	28.7 ± 4.9^{a}	2.31 ± 0.10^{a}	7.6 ± 3.0^{a}
7	33.1 ± 0.2	561 ± 20.1	12.4 ± 1.6^{a}	7.0 ± 0.9^{a}	19.4 ± 2.3^{b}	2.51 ± 0.17^{a}	10.5 ± 3.0^{a}
5	31.1 ± 0.1	503 ± 21.2	13.1 ± 1.4^{a}	6.5 ± 0.7^{a}	20.7 ± 1.9^{b}	2.73 ± 0.14^{a}	10.2 ± 0.6^{a}
6	30.1± 0.1	449 ± 8.4	8.8 ± 0.6^{bc}	3.7 ± 0.2^{b}	12.9 ± 1.6^{c}	2.38 ± 0.12^{a}	17.6 ± 1.1^{b}
4	29.3 ± 0.2	402± 22.9	6.0 ± 1.9^{b}	2.5 ± 0.8^{b}	10.7 ± 3.1^{c}	1.53 ± 0.30^{b}	35.9 ± 15.8^{c}

abc - means within columns with superscript not in common are different ($P<0.05$)

Table 6. Correlation coefficients of testicle size, sperm production and histological parameters related to sperm production. (n = 25)

Variables	testes weight	DSP/gr	DSP/bull	Total ESR	SEA	DGEL
SC	0.91	0.42	0.67	0.61	0.37	-0.50
P*	0.001	0.02	0.01	0.01	0.1	0.05
SEA	0.43	0.58	0.56	0.58	-	-0.54
P*	0.05	0.1	0.01	0.05		0.05
DGEL	-0.63	-0.68	-0.66	-0.61	-	-
P*	0.02	0.001	0.001	0.001		
DSP/gr	0.41	-	-	0 88	-	-
P*	0.02			0.001		
DSP/bull	0.67	-	-	0.81	-	-
P*	0.001			0.001		

*Significance probability of the correlation P>/R/

Table 7. Mean peak plasma T and LH (ng/ml) in response to 200ug of GnRH based on SC.

SC (cm)	n	LH	T
> 31	11	12.8	24.09[a]
< 31	14	12.1	14.01[b]

ab - means within columns with different superscript are different ($p<0.05$)

Table 8. Means ± S.E. for some reproductive traits measured for two breeds of beef bulls.

Traits	Breed	
	Simmental (n=63)	Hereford (n=58)
Age (wks)	55.19 ± 0.34	57.64 ± 0.50
Body wt. (Kg)	581.03 ± 6.41	530.41 ± 5.71
SC (cm)	36.69 ± 0.31	33.67 ± 0.33
Total Test. wt.(gm)	711.94 ± 16.38	567.58 ± 11.31
Total Epid. wt. (gm)	49.14 ± 1.15	43.83 ± 0.95
DSP/bull x 10^9	12.28 ± 0.62	10.07 ± 0.50
Total ESR x 10^9	24.56 ± 1.60	20.64 ± 1.29
DGEL (%)	24.17 ± 1.91	21.46 ± 1.96
Back fat (mm)	2.48 ± 0.16	5.90 ± 0.31
% Normal Sperm	70.46 ± 3.48	68.07 ± 3.21

Table 9. Correlation coefficient of testicular size and other quantitative parameters for Simmental bulls (n=63; 1990)

	% Normal sperm	DGEL	SC	Body weight	Back fat	Age	Motility
% Norm. sperm	1						
DGEL	-.103	1					
SC	.515	-.051	1				
Body weight	-.126	.114	-.003	1			
Back fat	-.212	.022	-.228	.254	1		
Age	.22	-.005	.135	-.038	.244	1	
Motility	.318	-.122	.367	-.14	-.174	.033	1

Table 10. Correlation coefficient of testicular size and other quantitative parameters for Hereford bulls (n=58; 1990)

	% Normal sperm	DGEL	SC	Body weight	Back fat	Age	Motility
% Norm. sperm	1						
DGEL	-.42	1					
SC	.36	-.044	1				
Body weight	.037	.237	-.095	1			
Back fat	.066	-.075	.033	.20	1		
Age	.196	-.034	-.148	.68	-.051	1	
Motility	.531	-.489	.26	-.223	.131	-.053	1